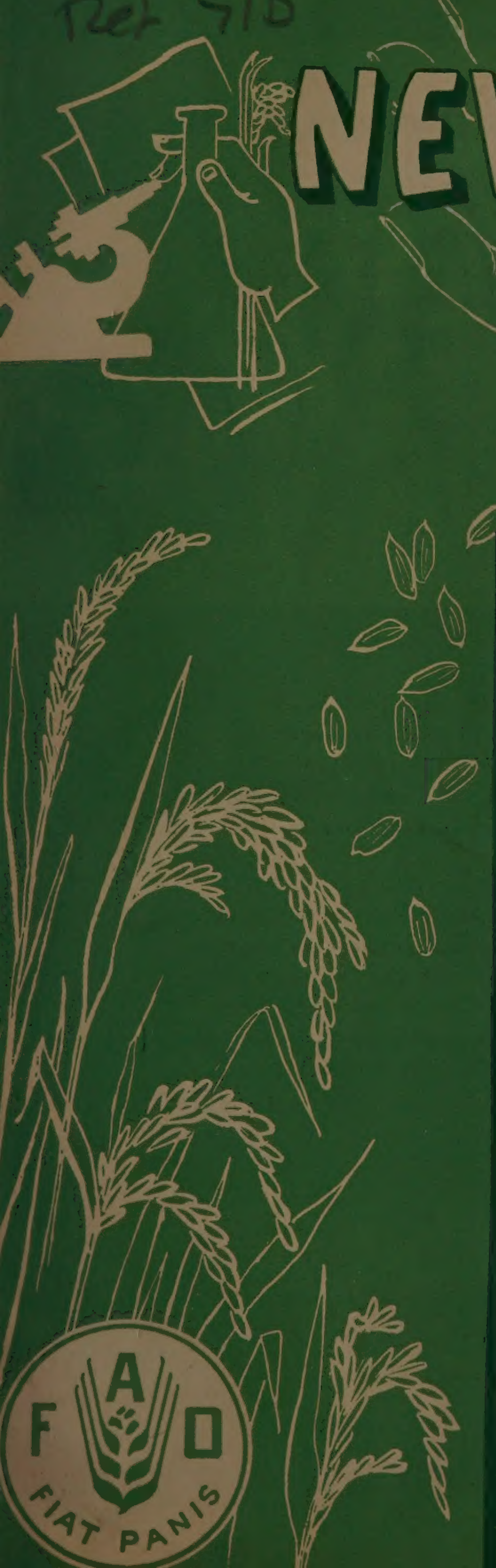
INTERNATIONAL RICE COMMISSION

NEWSLETTER



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FOOD AND AGRICULTURE ORGANIZATION
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THE INTERNATIONAL RICE COMMISSION

The International Rice Commission was established under the sponsorship of the FAO for the purpose of promoting national and international activity in respect of production, conservation, distribution and consumption of rice, except matters relating to international trade. At present it has 27 member governments, namely :

Australia	India	Netherlands
Burma	Indonesia	Pakistan
Cambodia	Iran	Paraguay
Ceylon	Italy	Philippines
Cuba	Japan	Portugal
Dominican Republic	Korea	Thailand
Ecuador	Laos	United Kingdom
Egypt	Malaya	United States of America
France	Mexico	Vietnam.

The First Session of the Commission was held in Bangkok, Thailand, March 1949; the Second Session in Rangoon, Burma, February 1950; the Third Session in Bandung, Indonesia, May 1952; the Fourth Session in Tokyo, Japan, October 1954; and the Fifth Session in Calcutta, India, November 1956; and the Sixth Session in Tokyo, Japan, October 1958.

For technical matters the Commission has special working groups. At first the Commission began with two working parties – one on rice breeding and the other on fertilizers – organized in 1950 and 1951 respectively. In 1954 the Commission added three more working groups to work on the topics of rice storage and processing; mechanization of rice production; and soil-water-plant relationships in the production of rice. In 1958, the Commission reorganized its auxilliary bodies into the following three technical working parties:

a. Working Party on Rice Production and Protection;

b. Working Party on Rice Soils, Water and Fertilizer Practices; and

c. Working Party on Agricultural Engineering Aspects of Rice Production, Storage and Processing.

GREEN MANURE CROPS IN RELATION TO PADDY RICE PRODUCTION IN SOUTHEAST ASIA

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I. INTRODUCTION

Under tropical conditions much of the organic matter present in rice soils is easily decomposed, and may be lost through oxidation or leaching. High temperatures, especially during the dry season, together with the frequent and often heavy rains during the rainy season, tend toward minimizing the quantity of humus present. Even in the southern part of the United States, difficulty is experienced in maintaining an adequate supply of soil organic matter.

Green manure crops can replenish much of the humus thus lost. It is the purpose of this paper to summarize and record certain pertinent data on the use and value of green manure crops in Southeast Asia. The countries included are China (Taiwan), Philippines, Cambodia, Indonesia, Thailand, Burma and India. The writer has drawn freely on published papers describing the results of research conducted in these countries. From some of these countries considerable material is available; from others it is very limited and inconclusive.

II. PURPOSES AND OBJECTIVES OF GREEN MANURING

What is a green manure crop? Green manure crops are those leguminous or non-leguminous plants which are incorporated with the soil, usually at the blooming stage, for the purpose of improving soil texture and increasing soil fertility. Leguminous crops are preferred because they have nodules on their roots which enable them to fix free nitrogen from the air. The actual fixation is done by soil microbiol organisms.

It has been pointed out (4)[1] that green manures differ from materials like rice straw or trash from sugarcane in having a low C/N ratio which facilitates their decomposition in the soil. Experimental results indicate that the leafy portion of green manures, which is rich in nitrogen, decomposes quickly in a rice soil having an abundance of water. However, the stem and other woody portions decompose slowly and are similar to slow-acting bulky organic manures which yield their nitrogen at later stages.

[1] Number in parentheses refers to literature cited.

Objectives of green manuring. Green manure crops are planted for one or more of the following reasons:

1. To add organic matter and nitrogen to the soil.
2. To control soil erosion.
3. To conserve soil fertility and soil moisture.
4. To increase the micro-biological activity in soil.
5. To improve the physical properties of soils.

III. CHOICE OF GREEN MANURE CROPS

Van der Giessen points out that a green manure crop for lowland rice in Indonesia should meet the following requirements:

1. Be capable of producting large quantities (at least 100 quintals[2] per hectare) of easily decomposable green material within a short period of time (2, 3, or atmost 4 months).
2. Be drouth resistant as it must usually be grown during the driest period of the year.
3. Be easy to cultivate, and resistant to insect pests and diseases.
4. Produce seed readily so that the farmer can grow his own seed on the rice bunds or on upland.
5. Be capable of being grown between plants of the crop preceding rice, i.e. cover crop.

In order to choose the green manure crop best adapted, regional trials in Indonesia were made under different soil and climatic conditions. Investigations to date have indicated that the three crotalaria species, *Crotalaria usaramoensis, Crotalaria anagyroides* and *Crotalaria juncea*, are very satisfactory. Because of its shorter vegetative period *Crotalaria juncea* is better adapted for crop rotation schemes and for growing between the plants of a cover crop (e.g. maize). Experiments also indicate that *Crotalaria juncea* is more suitable for the plains and less moist regions, while *Crotalaria anagyroides* and *Crotalia usaramoensis* are better suited to higher elevations.

Commonly grown crops used for the green manuring of rice in India are:

1. Sannhemp (*Crotalaria juncea*)
2. Dhaincha (*Sesbania aculeata*)
3. Guar (*Cyambpsis psoraloides*)
4. Phillipesara (*Phaseolus trilorus*)
5. Wild indigo (*Tephrosia purpurea*)
6. Cowpeas (*Vigna sinensis*).

Sesbania speciosa, introduced from Africa in recent years, has proved to be quite useful for varying soil and climatic conditions.

In certain areas the application of leaves of trees or shrubs as green manures has been found to be as effective for increasing rice yields as green manure crops grown *in situ*.

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2. One Quintal (q) = 100 kgs.

For heavy soils in the Madras, Andhra and Travancore-Cochin areas, the most commonly grown green manures are sannhemp and *Pillipesara.* For slightly saline and alkaline soils, dhaincha and *Sesbania speciosa* are used, while *Tephrosia purpurea* (wild indigo) and indigo are best for medium and light soils. Where heavy rainfall precludes the planting of green manure crops, leaves and tender twigs of trees are cut and used as green manures. Sometimes weeds like *Croton sparsiflorous* and *Leucaf aspera* are also employed for this purpose.

In Mysore, Hyderabad, and Madhya Pradesh in addition to the sannhemps, dhaincha and cowpea, *Cassia topa, Kodogira* and velvet beans (*Stizolobium deerugianum*) are quite satisfactory as green manure crops. In the irrigated areas of Mysore a mixture of sannhemp, cowpea, green gram, black gram and horse gram are sprinkled in between rows of non-legumes (sorghum, sesame, etc.) during summer and incorporated in the fields prior to transplanting rice in the monsoon season.

Kulthi (*Dolighos biflorus*), niger (*Guizotia abyssinica*) and wild indigo are used as green manure crops in the area of Bombay. These are in addition to dhaincha and sannhemp.

In general, sannhemp is used in dry areas whereas dhaincha is used on acid soils in wet areas. This is particularly true in Northeast India. Guar is also extensively used here where it supplements sannhemp and dhaincha.

The green manure crops grown in Taiwan can be classified into two groups as follows:

a. Single seeding.

The acreage of this group, as reported in the Taiwan Agricultural Yearbook for 1952, was 153,086 hectares, equivalent to 86.5 per cent of the total.

b. Mixed seeding.

This acreage amounted to 23,780 hectares, equal to 13.5 per cent of the total.

The "single seeding" refers to only one green manure crop whereas "mixed seeding" means that two green manure crops like radish and soybeans are sown simultaneously on the same plot of land.

According to Chu (1) the green manures used for single seeding in Taiwan are those shown in Table 1. The total acreage recorded is 146,901 hectares. However, Gleason (6) in a later paper states that the annual cultivation of green manures now approximates 200,000 hectares.

Sesbania sesban. Table 1 indicates that this legume is by far the most important green manure crop in Taiwan, occupying slightly more than half the total acreage. Its popularity apparently arises from the fact that the seed can be sown in moist soil, and will grow well under that condition in either sandy soils or clay loams. Growth is quite slow at first but becomes vigorous later. For the first rice crop it is usually seeded with soybeans, pea etc., as a mixed seeding. For the second rice crop it is grown

alone, as it is about the only green manure plant that will withstand the rainy days that follow harvesting of the first crop. It is seeded either broadcast or in rows at the rate of 30–40 kgs./ha.

Glycine max. Four varieties of soybean account for 21.5 per cent of the green manure acreage. These differ from one another most strikingly in seed color:

1. Blue soybean – most extensively grown.
2. Black soybean.
3. Pearl soybean.
4. White soybean.

As would be expected the soybeans grow best in the well-drained lighter soils like sandy loam or loam but will not grow satisfactorily in poorly drained heavy clay. For the first rice crop the seed is planted 2–3 weeks before the crop is harvested and 1–2 days before the water is drained off the paddy. The seed germinates in 2–3 days. Where drainage is poor or in areas with too much rain, the seed is sown either in hills or rows following the rice harvest. The seeding rate is 80–100 kgs./ha.

Raphanus sativus. This plant, though not a legume, is grown as a green manure crop for rice to the extent of 18.9 per cent. It is sown after harvesting the second rice crop at the rate of 10 kgs./ha. If mix-seeded, it is planted with pea or blue soybean and incorporated with the soil for the first rice crop in February or March. Raphanus sativus does well even in acid red-earth soils.

Pisum sativum. For best resulst the pea must be planted in well drained sandy loam or loam soils. It will not grow satisfactorily in heavy clay soils or on land receiving too much rain. It is usually planted after the second rice crop has been harvested, and plowed down the next spring for transplanting the rice crop. The seeding rate is 60–80 kgs./ha.

Of the many plants that might be used as green manure crops in Cambodia, only three are recommended (12). These are *Stereospernum jimbriatum*, *Leucaena glauca*, and *Cassia siamea*. The first will grow well on any soil. It should be cut when not more than one meter in height because at this stage the plant contains the most nitrogen. If allowed to grow until the stems are large, only the young stems and leaves should be cut for use. Some farmers, however, prefer the large plant as the trunk can be used for fuel, and the bark harvested for sale to Malaya and Vietnamese fishermen for dyeing their nets.

Leucaena glauca is grown for use as a house fence or in rows on waste land. The young leaves of this plant as well as those of *Cassia siamea*, which is grown either on sloping land or on rice field dikes, are satisfactory as green manures With both of these the leaves should be removed while the plants are in flower to obtain the best results.

As a whole attempts to use green manures in Burma have been unsuccessful (8). It has not been possible on the heavy

clay soils to establish good stands even when the seed is broadcast among the ripening rice plants. After the rice crop is harvested, the soil rapidly dries up and becomes so hard that green manure crops will not grow. Only in the middle zone north of the main paddy area has any success been attained with green manures. At this location sannhemp has been reported as being well adapted.

It seems to the writer, however, as a result of observations made during a 20 months tour of duty in Burma, that the possibilities for green manuring have not been fully explored. For example, sesbania sown at the beginning of the rainy season might make sufficient growth, even in lower Burma, to plow under as a green manure before planting the main paddy crop.

According to Ignatieff (9) green manure crops for increasing rice yields are usually not grown in the Philippines. However, considerable attention is paid to the plowing under of weeds.

In Thailand investigations with green manure crops for rice have only begun. In 1956, experiments were initiated using sesbania (*Sesbania roxburghii*), velvet beans, (*Stizolobinm atterimum*), mung bean (*Phaseolus aureus*), soybean (*Glycine max*), and Corotalaria (*Crotalaria juncea*).

IV. CULTURAL PRACTICES IN THE GROWING OF GREEN MANURE CROPS

Obviously, many factors affect the successful growing of green manure crops. If the plan is to cultivate these during part of the dry season, either sufficient water must be available to insure continuous growth, or, if possible, varieties used that are able to withstand drouth. Sethi et al (11) state that in India, green manuring has given the best results where an adequate supply of water was available.

On heavy wet soils legumes like certain sesbania species which grow well in water should be used. On well drained loam soils velvet bean, crotalaria, and soybeans are examples of satisfactory green manures. On the lighter soils the horse bean (*Mucuna capitata*) and sesbania (*Sesbania pustata*) seem to grow well. However, with this soil, upland rice varieties are often substituted for lowland paddy.

A. Effect of fertilizer. Fertilizer must be added to many rice soils if adequate growth of green manure crops is to be obtained. When growing legumes it may even be desirable to add a small amount of nitrogen to get the plants started. Some agronomists think it best to apply all the phosphorus and potash required for the rice crop at time the green manure crop is planted. Certainly, on poor soils such a procedure would result in much better growth of the green manure crop with little, if any, loss of phosphorus and potash in the drainage water. However, there is a distinct lack

of information on the problem as to whether phosphorus and potash should be added at the time the green manure crop is planted or applied just before transplanting the rice crop.

B. **Inoculation of soil or seed.** When a green manure crop is sown where it has never been planted before, its growth may be unsatisfactory because of the lack of certain nodule bacteria with which it normally grows symbiotically. In such cases the soil can be inoculated with soil from a field on which the legume has grown previously. Or, the seed may be inoculated with the proper organism before sowing.

In recent years, it has been pointed out that the particular strain of bacteria used can make a considerable difference in the growth of the legume concerned. Erdman (5) states that the more effective strains of legume bacteria can increase the yield or protein content of legumes as much as 20 per cent above the average for the natural legume bacteria in the soil. Furthermore, a strain may produce excellent results with one variety but poor results with a different variety. This is particularly true of soybeans and peas.

Quantitative data showing the effect of inoculating soybean seed on the subsequent yield of paddy rice, have been reported by Iso (10).

According to Chu (2) the exact concentration of the extractant mentioned in column headings (C) and (D) is not given in the original data. He also states that the soybean seeds were mixed with or soaked in the various media for three hours, then sowed in the field.

Reference to the table shows that with only one exception there was a marked effect on the yield of rice from noculating the soybean seed.

The data appear to substantiate the following conclusions:

1. Soaking the soybean seed in inoculated soybean extract was more effective in increasing rice yields than treating the seed with inoculated compost.
2. The more concentrated inoculated soybean extract produced the best results.
3. The effect of inoculation was greater at Hsinchu and Tainan than at Taichung.

Much research needs to be done in order to determine the best practices for the growing of green manure crops in any locality. These studies should include the wild indigenous varieties about which little is known in some areas regarding either their suitability or their response to fertilizers.

The data in table 3 are part of those reported by Chu (1) and indicate some of the recommendations made to the farmers of Taiwan who want to grow green manure crops for rice. Broadcasting the seed appears to be satisfactory for all crops except the pea. There is also a large variation in the amount of seed to be sown. For small seed like the radish

10-15 kgs./ha. is sufficient whereas for relatively large seed such as the soybean, from 80-100 kgs./ha. are necessary. Sometimes mixed seedings of two green manures are used.

General care. Once the crop has been sown, some attention to weed control will be necessary, especially if the green manure were planted in rows. The tropical velvet bean is an example. However, even with this crop, weeds will have but little adverse effect if prevented from being troublesome until the vines begin to cover the ground.

Legumes like sesbania, which are sown broadcast, may in themselves effect good weed control if the recommended seeding rate is used and if reasonably good weed control has been practised in previous years.

Insect attacks must also be repelled. Sometimes beetles seriously damage the leaves unless the plants are sprayed with the proper insecticide. And the stem borer can ruin a fine crop of crotalaria if not controlled.

A disease which may limit the usefulness of crotalaria (*Crotalaria juncea*) in Thailand is a virus. Serious trouble was experienced with it at the Roi-et Experiment Station this past year. In addition to modifying the character of the vegetative growth, seed production was entirely prevented.

V. EFFECTS OF GREEN MANURE CROPS

Nitrogen fixed by and chemical composition of various legumes. Quantitative data from this part of the world on the fixation of nitrogen by different legumes under various climatic and soil conditions is very limited. Much additional research is needed in this important field. Iso (10) made a study of the problem under Taiwan conditions. His data for green manures likely to be used in paddy rice production are shown in table 4.

The results show sesbania to rank first in this respect (91. 67 kgs. N/ha.) followed closely by crotalaria (88.84 kgs. N/ha.). The pea and cowpea fix less than half as much nitrogen as the top two while the blue soybean is the least efficient of the group. (26.14 kgs. N/ha.).

Table 4 also shows the percentage composition of the same legumes with regard to water, organic matter, phosphoric acid (P_2O_5) and potassium oxide. The analyses were made of the plants just before they reached the blooming stage. Sesbania is shown to contain more organic matter, phosphorus and potassium than any other legume. It also ranks second in nitrogen content. Crotalaria is second with regard to organic matter, but contains

the smallest amount of nitrogen; it is fourth with respect to both phosphorus and potash. The blue soybean heads the list in percentage nitrogen but is in fourth place considering its low organic matter content. It is interesting to note that the cowpea plant contains the least amount of potash, only 0.05 per cent.

Again, more information of this character is needed, especially to show the effect of climate, soil, and seasonal variations on nitrogen fixation and chemical composition.

Time and depth of plowing under green manures as affecting rice fields. Probably insufficient knowledge is available to indicate the best time for plowing down green manure crops where rice is to follow in the rotation. Generally, it is thought that green manures should be incorporated with the soil about the time the first plants come into bloom. But this assumes that soil, water and weather conditions are such as to bring the crop to that stage of growth in time. Some crops i.e. mung beans (*Phaseolus aureus*) have a short growing season while some others like velvet beans (*stizilobium atterimum*) and *Sesbania roxburghii* require several months to reach the flowering stage. The time for planting of the rice crop must also be considered.

Joachim as reported by Grist (7) maintains that green manure crops should be incorporated with the soil at the time it is puddled, i.e. late, as large quantities of ammonia are made available to the soil at all stages of the decomposition process coinciding with the period of crop growth. Maximum availability of ammonia occurs about four weeks from the time of puddling. If the green manures are turned under early, that is, when the soil is semi-dry, large quantities of nitrates are formed. On flooding the soil these may be lost either by being reduced to free nitrogen, or in the drainage water. If reduced to nitrites they can be harmful to the paddy seedlings if present in excess.

Published data available from Indonesia indicate no general agreement as to the best time for plowing under a green manure crop. Van der Giessen cites the work of Ossewarde who concluded from his experiments that the green manure crops should be plowed down about 10 days before planting rice. Van de Goor reached a similar conclusion, but in another case, turning under the green manure crop 1, 2, 3, and 4 weeks, respectively, before planting produced yields of 30, 31.2, 32.2 and 34.5 g./ha. of rice respectively. In all these experiments *Crotalaria juncea* was used.

At the Experimental Garden "Moeara", Indonesian workers carried out some investigations with *Crotalaria usaramoensis*. They found no difference on the yield of rice (about 20 q./ha.) whether the legumes were turned under 1, 14, 30, 43 or 60 days before planting.

In India, an interesting experiment (3) has been reported on this problem by the Central Rice Research Institute at Cuttack. The data are shown in table 5. It will be noted that incorporating the eight-week old sesbania crop immediately before planting gave a similar rice yield response as when plowed down four to eight weeks before planting. However, with the older twelve-week crop, it was better to turn it under 4 to 8 weeks ahead of planting. The conclusion drawn was to the effect that if the green manure crop is young and tender, it can be plowed under immediately before planting; but if old and woody, it should be incorporated several weeks ahead of planting the rice crop.

Not many results are available indicating the depth to which a green manure crop should be plowed in the soil. In actual practice this is difficult to accomplish. Data from the Punjab (3) indicate that the best depth, as measured by yields of the following rice crop, for placing dhaincha (*Sesbania aculeata*) into the soil is 10 inches.

Expected yields of green manures and their effect on the following rice crop. There are many experiments to show the direct effect of a green manure crop on the yield of paddy; only a few, however, will be presented here.

In India where irrigation water is available, green manures have proven to be very beneficial, and are probably the cheapest means for a farmer to increase his rice yields. Their major effect is undoubtedly due to their nitrogen content, but the favorable effects of organic matter and other nutrients cannot be over-looked. Green leaves from ponds, wastelands or forests may be added directly to the fields, or green manures like sesbania and cowpeas may be grown *in situ* and plowed under. Sethi et la (11) have summarized data obtained from various parts of India. These are recorded in table 6 and show the general nature of the response of paddy to green manuring in that country. The results indicate a high response to green manuring except at Jeypore in Orissa and Dabhoi in Baroda. At Jeypore the water held by the light loam soil is insufficient for decomposition of the green manure. At Dabhoi, where the soil is heavy, the rainfed water supply is undependable even for the rice crop. It is interesting to note that leaves, such as those from the forest, brought from the outside and trampled into the field, can be just as effective as a green manure crop grown *in situ*.

Van der Giessen reports that in Java the lighter textured soils low in both organic matter and nitrogen show the best results from the use of green manures. These soils include volcanic ash and sandy soils. However, both young and old lateritic soils, and lime marl soils respond well to green manure crops.

An example of the beneficial effect

of green manuring was shown in an experiment on tuff marl soil (Panarucan). A total of 206 q./ha. of green matter from *Crotalaria juncea* grown for 53 days and turned under 18 days before transplanting rice, resulted in an increase of 11.75 q./ha. of dry grain. Successive increases from the same green manure crop on the same land for four consecutive years were 8.8, 10.8, 11.7 and 15.7 q./ha., respectively.

On andesitic ash soil at Labrug, Java, *Crotalaria juncea* was grown on the same plots preceding the rice crop for 10 consecutive years. The data obtained are shown in detail in table 7.

In this experiment an average of 152 q./ha. of *Crotalaria juncea* grown for 72 days was incorporated with the soil 10 days before transplanting the rice. As shown in the table, this treatment resulted in an average increase in paddy production of 7.44 quintals per hectare, or an increase over the control of 19.4 per cent.

Since this experiment ran for 10 years on the same field, the data are of interest in several respects. As might be expected there was considerable variation from year to year in the amount of increase over the check. In 1935-1936 this increase was only 3.7 quintals, while in 1937-1938 the increase was 13.6 quintals. One might have expected a progressive increase in yield of the treated plot over the control. However, the data do not show this. In fact the tenth year this increase amounted to only 5.3 q./ha. while it was 6.0 q./ha. the first year. This could mean that in Java, under the conditions of the experiment, it would be necessary to grow a green manure crop each year if increased yields were to be maintained.

In another experiment at Tambakredjo on a yellow-brown, old andesitic tuff-lateritic soil, essentially the same results were obtained where a green manure crop was turned under every year for 10 years. In this case *Crotalaria anagyroides* was the green manure used. It was grown for 5 months, and averaged 140 q./ha. of green matter when incorporated with the soil 10 days before transplanting the rice crop. The first year the green manure resulted in an increase over the control plot of 7.3 q./ha. while the tenth year it was only 6.9.

In Thailand the velvet bean (Stizilobium atterimum) shows considerable promise as a green manure crop when grown in certain localities. For example, near Tan Yong Mat in southern Thailand, this crop was given a trial planting in 1958. The soil was a heavy silt loam. In a replicated experiment where it received at the time of planting a basic application of fertilizer low in nitrogen, the average yield of green material was 20.5 metric tons/ha. Unfertilized the

average yield was 17.4 metric tons/ha.

Ceylon (9) has published data comparing the effect of green manures, compost and commercial fertilizers on the yield of broadcast paddy. These results are shown in table 8.

Treatment 4 of the table indicates that the application of 6 tons of green manure gave even better results than the addition of 10 tons of either compost or cattle manure. The original publication does not indicate the kind of green manure used nor does it say whether it was grown *in situ* or brought to the experiment from outside. Another interesting comparison can be made between treatments 6 and 7. When bonemeal was applied alone the yield of rice was 155.9 kgs./ha. or 8.2 per cent over that of the check plot. When, however, 6.3 tons of a green manure were added in addition to the bonemeal, the increase over the control amounted to 543 kgs./ha. or 28.6 per cent.

Chu (1) reports that for the four green manure crops shown in table 3 yields of each varying from 7,700 to 15,500 kgs./ha. may be expected under Taiwan conditions.

Attempts to measure the value of green manures in terms of commercial fertilizers have also been made. At the Agriculture Institute in Bogor, green manuring with *Crotalaria juncea* gave results equal to or exceeding that of manuring with 1 q./ha. of ammonium sulphate. In another comparison green manuring was considered to be qual to from 0.5 to 1.0 q./ha. of double superphosphate. It is pointed out that on one hand green manuring is cheaper than commercial fertilizers but on the other hand an additional crop may have to be sacrified.

Other effects of green manure crops. Indonesian investigators have noted other effects from green manures in addition to increasing rice yields. In many cases the time for maturing varieties is shortened. If large quantities of easily decomposable materials are plown down the lodging of varieties sensitive thereto may be increased. Also, what are called "mentek-symptoms" shown by rice plants disappear more rapidly on green manured areas than they do on unmanured plots of the same variety.

Van de Goor investigated the protein content of half polished rice grown in some of his green manuring experiments. In one test the protein content of the half polished rice produced on control plots was 7.1 per cent, whereas grain harvested from plots receiving 250 q./ha. of green *Crotalaria usaramoensis* contained 9.6 per cent.

In another test the following data were obtained:

Crotalaria (*Crotalaria usaramoensis*) added to Soil (Quintals per hectare)	Protein content of half polished rice per cent
Control	7.1
100	7.7
200	9.8
300	10.9

The statistical significance of these values is not indicated but the data do show that the protein content of the rice grain increased with the quantity of green manure added.

Discussion. The data in this report show that green manure crops can be effective in increasing both the yield and quality of rice. However, in some countries in Southeast Asia like Burma and Thailand, such investigations have not yet proceeded far enough to obtain needed answers to many of the problems. These researches should be carried on but confined if necessary to areas where water is not a limiting factor.

Often native plants can be found which are already adapted climatically and which can be used to considerable advantage. *Sesbania roxburghii* is one of these presently under study in Thailand. There are also some indigenous tropical kudzus which might prove to be of value.

Another approach is to obtain seed of green manure plants which have given good results in nearby countries. An example of this is the tropical velvet bean (*Stizilobium atterimnm*) which Mr. W.H. Cummings introduced to Thailand from Ceylon.

It is unnecessary here to review the techniques for the growing and field testing of green manures. However, it should be remembered that they must be economically feasible, and their use for rice should result in a profit to the farmer. It is not so much a question as to whether increased yields will result, but rather a matter of whether or not the increased yields pay. However, the very fact that so many thousands of hectares of green manure crops are grown in certain countries of Asia is proof in and of itself that such a practice must pay.

It is hoped that the necessary research for determining the kinds of green manure crops adapted to the various paddy soils of Thailand as well as the best methods for growing them will be well supported by the Rice Department. Both technical and financial supports are needed. Possibilities for the profitable use of such crops by farmers as a substitute in part for high cost commercial fertilizers are most encouraging.

VI. SUMMARY

This paper summarizes the important results from research with green manure crops for increasing paddy rice yields in Southeast Asia. These crops are of much importance to the farmer of India, Indonesia and Taiwan because they are an economical way for him to add both organic matter and nitrogen to his soil at minimum cost. In Burma, Thailand, the Philippines and Cambodia, however, green manures are either not used or their possibilities are just beginning to be investigated.

For the region as a whole, green manure crops which have been tried successfully include various species of sesbania and crotalaria together with peas, soybeans, mung beans and radish. In India, particularly, leaves from forest trees and shrubs mixed with the soil have been about as effective as the growing of green manures *in situ*.

Inoculation of the seed or soil with nodule organisms is usually necessary for the satisfactory growth of legumes on soils never before planted to such crops. An experiment conducted in Taiwan showed the amount of nitrogen fixed by legume organisms varied from 26.14 kgs. N/ha. for the blue soybean to 91.67 kgs. N/ha. for sesbania. These quantities are equivalent to 130.7 and 458.3 kgs./ha., respectively, of ammonium sulphate (20 per cent N).

In a series of experiments reported from India, the response of rice to green manuring varied from 2 to 114 per cent depending on the specific crop used, location, soil, etc. At Java in Indonesia, *crotalaria juncea*, grown annually for ten years, increased rice yields by an average of 19.4 per cent above those from unmanured plots. In Ceylon, six tons of green manure per hectare was more effective in increasing rice production than either 10 tons of cattle manure or 10 tons of compost. Other experiments from Indonesia indicate that the protein content of rice grain is increased with the quantity of green manure added to the soil.

It is suggested that investigations already in progress with green manure crops in Thailand be continued.

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Table 1. Kind, Acreage and Location of Green Manure Crops Grown in Taiwan.

Kind of Green Manure	Cultivated Acreage Hectares	Per cent of total	Locality Where Grown
Sesbania (*Sesbania sesban*)	73,607	50.1	Mostly in Southern Taiwan. Pingtung, first; Tainan, Yunlin, Chiayi and Kaohsiung follow in order.
Soybean (*Glycine max*)	31,539	21.5	Mostly in Southern Taiwan Pingtung, first; Chiayi, Changhwa, Hwalien, and Kaohsiung follow in order.
Radish (*Raphanus sativus*)	27,747	18.9	Distributed in Northern and Central Taiwan. Miaoli, first; Hsinchu, Taichung, and Taoyuan follow in order.
Pea (*Psium sativum*)	7,577	5.1	Mostly in Central Taiwan. Changhwa, first; Taichung and Yunlin follow in order.
Rapeseed (*Brassica campestris*)	2,199	1.5	Central Taiwan. Yunlin, Changhwa, etc.
Green bean (*Phaseolus radiatus*)	1,494	1.0	Southern Taiwan: Tainan.
Cowpea (*Vigna sinensis*)	1,405	1.0	Southern Taiwan: Tainan.
Peanut (*Aarachis hypogaea*)	1,333	0.9	Central Taiwan: Yunlin.
Total	146,901	100.0	

Table 2. Effect of Inoculating Soybean Seed Used for Growing the Green Manure Crop on the Yield of the Following Rice Crop (Taiwan Agricultural Association)

Location in Taiwan	(A) No Inoculation	(B) Inoculation of Nodule Bacteria in the Compost	(C) Inoculation of Nodule Bacteria in the Extractant of Soybean Meal	(D) Same as (C) but more concentrated Extractant
	Koku[2]	koku	koku	koku
Hsinchu				
1. Yield of brown rice per *ko*[1]	12.051	13.668	15.783	16.249
2. Index	100	113.4	130.9	134.8
Taichung				
1. Yield of brown rice per *ko*	17.773	17.478	19.531	21.022
2. Index	100	98.3	109.8	118.2
Tainan				
1. Yield of brown rice per *ko*	22.151	–	27.399	32.857
2. Index	100	–	123.6	148.3

[1] 1 ko = 0.97 hectare

[2] 1 koku = 1.80 hectoliter

1 koku of brown rice = 139 kgs. of Native Variety (Indica) or
= 143 kgs. of Ponlai Variety (Japonica)

Table 3. Recommended Practices in the Growing of Green Manure Crops for Rice (Taiwan)

Kind of Green Manure Crop	Time of Sowing	Methods of Sowing	Seeding Rate (kgs./ha.)	Usage
Blue or black soybean (*Glycine max*)	Oct. – Nov.	Broadcasting drilling or dibbling	80 – 100	For green manuring of first rice crop
Pea (*Pisum sativum*)	Oct. – Nov.	Dibbling	60 – 80	– do –
Radish or rape seed (*Raphanus sativus*)	Nov.	Broadcasting or dibbling	10 – 15	– do –
Sesbania (*Sesbania sesban*)	May – June Oct. – Nov.	Broadcasting	30 – 40	For green manuring of both the first and second crops of rice

Table 4. Nitrogen Fixed by and Chemical Composition of Certain Leguminous Crops (Agricultural Research Institute, Taiwan)

Green Manure Crop	Nitrogen Fixation Kgs N/ha	Chemical Composition (per cent)				
		Water	Organic Matter	N	P_2O_5	K_2O
Pea (*Pisum Sativum*)	35.35	85.50	13.09	0.45	0.10	0.35
Blue Soybean (*Glycine max*)	26.14	78.97	18.52	0.62	0.09	0.32
Sesbania (*Sesbania sesban*)	91.67	69.96	28.64	0.47	0.12	0.42
Crotalaria (*Crotalaria juncea*[1])	88.84	75.62	22.85	0.37	0.08	0.14
Cowpea (*Vigna sinensis*)	34.10	79.70	19.04	0.43	0.08	0.05

[1] Not used as a green manure crop for rice in Taiwan, but included here because its possibilities for rice are being investigated in Thailand.

Table 5. Effect of Age and Time of Plowing Under *Sesbania aculeata* on the Yield of Rice (Central Rice Research Institute, Cuttack, India)

Treatment	Yield of paddy in lbs. per acre [1] — Age of legume when plowed under: 8 weeks	12 weeks
1. Control (No treatment)	2,805	
2. Sesbania plowed down 8 weeks before planting	3,017	3,141
3. ,, ,, ,, 4 ,, ,, ,,	3,024	2,965
4. ,, ,, ,, just ,, ,,	3,102	2,879

[1] Based on two year results.

Table 6. Response of Rice to Green Manuring in India (Central Rice Research Institute, Cuttack, India)

State	Station	Kinds of leaf	Quantity or level of N per acre lbs.	Average yields in lbs. per acre: Control	Green manure	Increase green manure over control per cent	Remarks
Hyderabad	Himayat-sagar	Sannhemp[1]	6,000	840	1,800	114	Average of 1941–42 to 1943–44. *Abi* Crop (Rainy season)
Hyderabad	Himayat-sagar	Daincha[2]	6,000	840	1,515	80	G.M. applied along with 30 lbs. P_2O_5 acre

Orissa	Cuttack	Daincha	45 lbs. N	1,916	2,532	32	Average of 1939–40 to 1943–44
Orissa	Berham-pur	Daincha	45 lbs. N	2,072	2,517	21	Average of 1939–40 to 1941–42
Orissa	Jeypore	Daincha	40 lbs. N	2,053	2,094	2	Average of 1944–45 to 1947–48
Bombay	Karjat	Rui leaves (*Bombax malabaricum*	60 lbs. N	2,650	3,666	38	Average of 1925–26 to 1927–28
Bombay	Karjat	*Ipomea carnia*	60 lbs. N	2.650	3,350	26	Average of 1925–26 to 1927–28
Bihar	Sabour	Daincha	150 mds.[3]	1,610	2,587	61	1939–40
Bihar	Sabour	Sannhemp	150 mds.	1,610	2,642	64	1939–40
Bihar	Gaya	Daincha	40 lbs. N	1,332	1,737	30	Average of 1940–41 and 1941–42
Kashmir	Kudwani	Lentil	75 lbs. N	1,625	2,504	54	Average of 1944–45 to 1947–48
Baroda	Dabhoi	Daincha	–	532	422	Decrease	Average of 1940–41 and 1942–43
Baroda	Dabhoi	Urid (Phaseolus mungo)	–	456	546	20	Average of 1943–44 and 1945–46

[1] Sannhemp = *Crotalaria juncea*

[2] Daincha = *Sesbania aculeata*

[3] One mond = 82 lbs

Table 7. Effect on the Yield of Rice of Crotalaria Juncea when Used as a Green Manure Crop and Grown on Andesitic Ash Soil in Java

Year	Yield of dry panicles in q/ha [1]		Increases in q/ha. S=Significant NS=Nearly significant	Rice Variety
	Control	Manured		
1930-31	47.2	53.2	6.0 S	Gropak wuluh (beared)
1931-32	31.8	37.2	5.4 S	Gropak byar (beerded)
1932-33	37.5	48.1	10.6 S	Gropak byar (bearded)
1933-34	51.7	59.5	7.8	Gropak serung (bearded)
1034-35	31.8	44 8	13.0 S	Gropak serung (bearded)
1935-36	27.2	30.9	3.7 N.S.	Gropak serung (bearded)
1936-37	38.6	43.8	5.2 S	Gropak serung (bearded)
1937-38	34.1	47.7	13.6 S	Gropak serung (bearded)
1938-39	42.1	45.9	3.8 N.S.	Tjina (unbearded)
1939-40	40.7	46.0	5.3 S	Tjina (unbearded)
Total	382.7	457.1	74.4	
Average	38.7	45.71	7.44	

1 One quintal = 100 kgs.

Table 8. Comparison of Various Fertility Treatments for Increasing the Yield of Broadcast Paddy (Average of several years results from Ceylon) [1]

Treatment per Hectare		Yield of Paddy	Increase over control in	
No.	Kind	Kgs./Ha.	Kgs./Ha.	Per cent
1	Control	1,897.7		
2	Compost, 10 tons	2,214.9	317.2	16.7
3	Cattle Manure, 10 tons	2,268.7	371.0	19.5
4	Green Manure, 6 tons	2,295.6	397.9	21.0
5	Compost, 4 tons and Ammophos, 63 kilograms	2,290.2	392.5	20.7
6	Bonemeal, 125 kilograms	2,053.6	155.9	8.2
7	Bonemeal, 125 kilograms and green manures, 6.3 tons	2,440.7	543.0	28.6
8	Ammophos, 125 kilograms	2,4407	543.0	28.6
9	Superphoshate, 94 kilograms and Am. sulphate, 94 kilograms	2,478.3	580.6	30.6

[1] Basic information supplied The Woking Party on Fertilizers of the International Rice Commisson, 1951, by D.E.V. Koch, Chemist, Department of Agriculture.

RICE SEED MULTIPLICATION AND DISTRIBUTION IN TAIWAN

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I. INTRODUCTION

Rice is the most important food crop in Taiwan as well as one of its major foreign exchange earners. Long ago, during the period of Japanese occupation, a rice seed improvement program had been in operation. But, as a result of the destruction of World War II, seed improvement work was almost suspended at the end of it. However, since 1945 when the Chinese government took over the island, considerable improvement has been made to strengthen the system of rice seed multiplication and distribution. The improvement covers (1) a more adequate supervision over the multiplication of seeds; (2) the reduction of extension seed farms or certified seed farms form formerly 7,000 to 3,000 for better management; (3) the establishment of a unified system in approving new varieties for multiplication and distribution; (4) the provision of facilities for all seed farms; and (5) the adoption of a rice seed certification system. Every year, a total of 9,000 M.T. of pure rice seeds is produced, enough to supply 150,000 ha. of paddy fileds, or 1/3 of the total Ponlai rice (Japonica type) acreage in the island. Since most of the rice fields in Taiwan are double cropped each field can have a fresh supply of pure seeds once in every three crop seasons.

II. PROCEDURE OF APPROVING NEW VARIETIES FOR MULTIPLICATION

The rice breeding work is carried out in seven district agricultural improvement stations (DAIS) and the Taiwan Agricultural Research Institute (TARI), all of which are under the administration of the Provincial Department of Agriculture and Forestry (PDAF). When a new variety is recommended by a station, its experimental records will have to be screened by a Rice Improvement Conference (RIC) convened by the PDAF before being multiplied. The Rice Improvement Conference is composed of the leading rice breeders and agricultural administrators concerned. At its annual meeting the conferencs examines the new varieties recommended, and decides whether they should be included in regional trials, or be multiplied immediately and extended. It also exchanges views among the rice breeders regarding various problems of the rice breeding program.

A new variety, when recommended, should be a high yielder than the existing ones, and must be resistant to rice blast and adaptable to the area in which it is to

be extended. After a new variety is approved, the PDAF will then officially inform the related foundation seed farms (the district agricultural improvement station) to include the new variety on the list for multiplication. When a new variety is released for extension, the existing one is usually discarded. This will prevent the number of rice varieties under extension from becoming too big. For each township, the Ponlai rice variety to be multiplied seldom exceeds four in number, and the total number of rice varieties raised on the foundation seed farms in 1958 for the whole island was 22.

III. THE RICE SEED MULTIPLICATION SYSTEM AND ITS OPERATION

There are three categories of seed farms under the present rice seed multiplication system in Taiwan (1) foundation seed farms, (2) stock seed farms, and (3) extension seed farms.

On the foundation seed farm, the breeder's seed is used for multiplication. Utmost care is taken to maintain its genetic identity and purity. Only one plant is transplanted into a hill for the convenience of observation. Any off-types or questionable plants should be rogued. As the purpose of the foundation seed farm is to produce seed of high purity, whether its yield is high or low is of little concern. The foundation seed farm is expected to yield only 1,500 kgs./ha. Under the normal rate of seeding (60 kgs./ha.), the above amount of seed produced will be enough for planting 25 hectares of stock seed farms the following season. Since the managment of the foundation seed farms requires special knowledge of the genetic charaters of the varieties under multiplication, seven district agricultural improvement stations in the island are charged with the responsibility. The foundation seed is supplied free.

The foundation seed is then multiplied on the stock seed farms, at the rate of sixty kilograms per hectare. The operation of the stock seed farm is quite similar to that of the foundation seed farm, except for 4–6 plants instead of a single plant planted per hill. The stock seed farms may be operated by the local governments, farmers' associations or contracted farmers under the supervision of the goverment and the associations. The projected yield of a stock seed farm is 2,400 kgs./ha., an amount enough to plant 40 ha. of extension seed farms. In order to permit better management and supervision, the size of a stock seed farm should not be smaller than one hectare. The stock seeds are generally bought by the prefectural governments and then given to the extension seed farms for multiplication without charge.

The third step of the seed multiplication system is the extension seed farms wihch obtain their supply of seeds from

the stock seed farms. These extension seed farms are operated mostly by contracted farmers. They should also be well managed. Roguing must be done four times in the first crop and three times in the second crop in order to eliminate any barnyard grasses, off-types and other mixtures that may be present. The size of an extension seed farm should not be smaller than half an hectare. The expected yield of an extension seed farm is the same as that of a stock seed farm. That is 2,400 kgs./ha. enough to plant 40 hectares of farmers' paddy fields.

It can thus be seen that the breeder's seed will go through these three steps of multiplication before reaching the farmers. In Taiwan, rice is generally grown twice a year in the same field, and the same variety of the Japonica group can be planted in both seasons of the year. It takes only three consecutive crop seasons or one and a half years in Taiwan, for a rice grower to obtain a supply of pure seeds.

The pure seed produced from the extension seed farms may be obtained by the rice farmers by exchanging with their own seed either at the rate of one for one or at a premium of not more than 20 per cent. This exchange is usually effected at the extension seed farms.

A summary table showing the seed multiplication system of Ponlai rice as now practised in Taiwan is given below.

	Sources of supply	No. of plants per hill	Projected yield	Operated by
			kg/ha.	
Foundation Seed Farms	Breeder's seed	Single plant	1,500	District Agricultural Improvement Stations
Stock Seed Farms	Foundation Seed Farms	5 plants	2,400	Government Agencies and farmers' associations
Extension Seed Farms	Stock Seed Farms	5 plants	2,400	Contracted farmers

IV. STORAGE AND DISTRIBUTION OF RICE SEEDS

The methods of storage and distribution of rice seed vary with the stage of seed multiplication and also the length of time of storage required.

The foundation seed After being properly dried (13 per cent moisture content), the seed is stored in wooden bins, installed in a storage house of the

district agricultural improvement stations. Each wooden bin (2.4 m.×1.06 m×2.7m.) is lined inside with galvanized sheet to keep the seed dry and to prevent damage from rats. The wooden bin has a lid on the top for loading seed, and an outlet near the base at the front for unloading it. Each wooden bin has a storage capacity of 2,400 kgs. of rice seed. It is installed 30 cm. above the ground in order to prevent moisture. Usually a series of wooden bins is installed in the same house for storing seeds of different varieties.

Before the planting season begins, the prefectural farmers' association will obtain from the district agricultural improvement station the required amount of seed according to the total acreage of stock seed farms under its supervision and manage to have it distributed for planting.

The stock seed. After being properly dried (13 % moisture content) the seed is kept either in wooden bins, as described above, or in metal bins which are much smaller than the former. The metal bin is either made of galvanized iron or aluminium sheets, and has a capacity of 160 kgs. The metal bin is 90 cm. high with a diameter of 66 cm. and has a metal lid. The metal bin can be moved from place to place. Because of its smallness, it can be installed easily. It is light, rat-proof, and good for keeping seeds in relatively small amounts. It is popularly used in rural Taiwan. At some stations, even the foundation seed is stored in this kind of metal bins.

As mentioned earlier, the stock seed from the stock seed farms is bought by the prefectural government in accordance with their requirements. Then the prefectural farmer's association or the township office will collect the seed and store it either in township farmer's associations or township offices where the extension seed farm operators will receive their share for planting.

The extension seed Being produced from the extension seed farms, the extension seed, except that for intermediate planting, is kept mostly in jute bags. The term "intermediate rice crop" is used for rice which is planted later than the normal first crop but earlier than the normal second rice crop. It is grown only once a year in certain areas, where irrigation water is insufficient to grow two rice crops a year. In this case, the seed will have to be stored for about six months. A bowl-typed storage hut has been designed for this purpose. Split bamboo strips are woven into a bowl shape container which is seated on a heavy wooden base. The bamboo frame is then plastered, both inside and outside, with a mixture of lime, sand and mud. This will prevent the penetration of moisture, reduce the fluctuation of temperature and also keep the rats out. On one side of the storage, there is a small opening for loading or unloading the seed. Over the top there is a thatched

roof. This storage hut is small, with a capacity to store 3,000 kgs. of seed, and can be erected by the farmers themselves in their yards. So it is generally adopted in areas where the intermediate single rice crop is grown.

V. RICE SEED CERTIFICATION

The Ponlai Rice Seed Certification System was inaugurated in Taiwan in 1957. Field inspection is required of all seed farmers, while laboratory studies will cover all the foundation and stock seed farms and one third of the extension seed farms. The details of the system will not be described here. However, the field and seed standards are presented hereunder for reference.

Ponlai Rice Seed Certification Standards

(1) Field standards

Factor	Maximum permitted in each class: Foundation	Stock	Extension
Other varieties	None	None	None
Barnyard grass	None	None	None
Objectionable weeds	None	None	10 plants per 1,000 sq.m.
Disease affecting quality of seed or transmissible through planting stock	None	None	None

(2) Seed standards

Factor	Standards for each class: Foundation	Stock	Extension
Pure seeds (minimum)	99.8%	99.5%	99%
Inert matter (minimum)	0.2%	0.5%	1%
Other varieties (maximum)	None	None	25 per kilo.
Barnyard grass (maximum)	None	None	5 per kilo.
Weed seeds	None	None	2 per kilo.
Germination (minimum)	90% (1st crop) 85% (2nd crop)	90% (1st crop) 85% (2nd crop) 80% (Intermediate crop)	90% (1st crop) 85% (2nd crop) 80% (Intermediate crop)
Moisture content (maximum)	13%	13%	13%
Weight of 1,000 kernels (minimum)	(Varies with the varieties and localities so it is not included here.)		

VI. CONCLUDING REMARKS

The success of this rice seed multiplication and distribution system lies in (1) the applicability of the system; (2) the careful selection of seed farm operators and the provision of necessary physical facilities; (3) close supervision of the seed farm by the government; and (4) the incentives for producing pure rice seeds. Lack of any of these factors will make the program less successful.

BRIEF REPORT ON THE AGRICULTURAL MECHANIZATION IN TAIWAN

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When the first 4-year agricultural, production plan was prepared in 1953, the Government found that for the intensive tilling of the 870,000 hectares of land in Taiwan, there would be a need of 110,000 head of buffaloes in addition to the 390,000 head Taiwan already had then. The Joint Commission on Rural Reconstruction, after making a careful study of this problem, realized that to increase the buffalo population would not only take a long time, but a big area of land would also be needed to grow buffalo feed. In view of the rapidly increasing population in the island, more land was needed for food production. Therefore, the use of power farming equipment became the only feasible way to solve the power shortage problem.

The experiment with small size power farming equipment was started by the Joint Commission in 1954, in cooperation with local agricultural authorities. Seven different models of garden tractors ranging from $1\frac{1}{2}$ HP to 10 HP were introduced from the U.S.A., and distributed to private farms, agricultural schools and agricultural improvement stations for trial use. The general reaction was not very good, because they were heavy and could not be used on paddy fields. The handle and chassis were too high for the average sized Oriental people to operate, and the prices were also high.

The Joint Commission then experimented with some of the Japanese power tillers, which were designed to be used on both dry land and paddy fields. Two different types of power tillers were selected for test use. One was the typical Japanese driven type rotary tiller, which has been popularly used in Japan for the past two decades. The other belonged to the combined American and Japanese tractive and rotary type power tiller category, which was also new in Japan then, but we thought it might better fit our farming conditions. They were both tried on farmers' land. The general comment was that the tractive and rotary type power tiller would definitely be more acceptable to Taiwan farmers, because of its light weight, compact size, easy operation, high maneuverability in small fields,

ability to perform more kinds of work in and around the farm, and, most important of all, low cost.

The Joint Commission therefore granted 13 such tractive and rotary type power tillers to 13 agricultural improvement stations on the island, and helped to train operators for these stations, so that they could start a systematic power tiller adaptability test to find out the proper way of using power tillers under Taiwan conditions, and also their working efficiency and economic value as compared with the use of buffaloes. The result indicates that a power tiller can plow the land about one inch deeper within 2/3 to 1/2 of the time required by a buffalo. The 2.5 HP machines are suitable for fields of light soil, 3.5 HP machines for heavy soil, and 5 HP machines for farms of much heavier soil, or for those farmers who want to do some other jobs requiring greater power. Power tillers of this type can also be used for row crop inter-tilling; weeding; hilling ridges; and propelling power sprayers, rice threshing machines, sweet potato slicing machines, winnowing machines, etc. When attached to a trailer, the power tiller can serve as a transporting vehicle for a load of up to 600 kgs. at 15 kilometers per hour.

With the assistance of the Joint Commission, the National Taiwan University has conducted a one-year course in agricultural engineering to train farm machinery technicians for the agricultural experiment stations, so that they can operate the power tillers on the stations and help to train local farmers in using them too. In addition, the following steps have been taken to promote power farming in Taiwan:

1. **Encouraging domestic machinery manufacturers to make power tillers.** Taiwan is short of foreign exchange. It is impossible to supply every needy farmer with a power tiller imported from a foreign country. The Joint Commission, in cooperation with the Industrial Development Commission, therefore. encouraged some local machinery manufactureres to start manufacturing power tillers; not to copy wholly any imported model, but make some adjustments to fit our local agricultural conditions. Now there are six such manufacturers in the island: four for the tractive and rotary type tillers, and two for the driven type rotary tillers. Three of them have already sold a total of about 100 power tillers. The other three have started manufacturing engines; one for four stroke gasoline engines, one for water cooled diesel engines.

2. **Promoting the use of power tillers.** Petroleum is strictly under government control. Since the use of power tillers in the island is of recent origin, there was no provision made in the old regulations to provide gasoline or diesel oil for them. At the suggestion of the Joint Commission, the Provincial Government has promulgated in February 1958 a new regulation governing the use of petroleum fuels for power tillers. The

Provincial Government has also exempted power tiller users from paying licence tax. The Legistrative Yuan of the National Government is now considering a national act for the further promotion of agricultural mechanization.

3. Providing farm machinery purchase loans. A power tiller, with all attachments, costs about 4-5 times as much as a water buffalo. Many farmers and agricultural agencies have suggested a subsidy system to encourage the use of power tillers. However, it is believed that the power tiller is a part of the production cost and farmers have to pay for them. The Provincial Food Bureau, the Land Bank, and the Provincial Cooperative Bank have therefore all established farm machinery purchase loans. Farmers may borrow 100 per cent of the purchase cost from the Food Bureau if they agree to repay the loan in terms of paddy rice; or up to 70% of the purchasing cost from the two banks. The repayment is to be made within three years.

4. Training farmers in power farming. Agricultural extension in Taiwan is undertaken by the farmers' associations. Since power farming is new, short term training courses have been conducted for farmers on the selection, operation and utilization of power tillers. They in turn serve as demonstrators for power farming to their neighbours.

With all these measures, it seems that rural Taiwan is progressing toward mechanization. The number of power tillers has increased from zero in 1953 to seven in 1954, nine in 1955, 60 in 1956, 180 in 1957 and 400 in 1958. In promoting farm mechanization in Taiwan, there have been different opinions. Some are in favor of cooperative owning and using; some insist that public or private concerns should own the power tillers and offer custom plowing service to the farmers. But the farmers prefer individual ownership. Sometimes two or three neighbours or relatives may own a power tiller and use it in turn. Since farms in Taiwan are privately owned and individually managed, famers like to exercise complete control over their power farming equipment. They also know that the power tiller can be used in many other ways in and around their farms besides plowing, and they will not be able to get all these advantages if only custom services are provided. Many a power tiller owner can now be seen taking his whole family on a trailer to move about.

For the further development of power farming in Taiwan, the following measures seem to be necessary:

1. Establishing a network of power tiller repair service stations in rural Taiwan. This can be done by the manufacturers, distributors, importing agents, and farmers' associations either individually or cooperatively.

2. Establishing a power tiller testing organization. Since so many domes-

tic manufacturers are interested in making power tillers, the establishment of an official testing organization seems to be necessary in order to protect farmers' interests and to help improve local machinery. Helpful advice can also be provided for importers of power tillers from abroad.

3. **More research and education necessary.** There has been a feeling that the local machinery manufacturers, who now make power tillers, are unfamiliar with the customers' needs; and that farmers don't know power farming. This is the place where the agricultural experiment stations can be helpful. These stations can advise the manufacturers on the farmers' needs and test their machinery, and can also help to train farmers in using them.

Of the 400 power tillers now in use in Taiwan, 70 belong to the diesel or kerosene driven type, while the balance belong to the tractive and rotary type that are equipped with air cooled gasoline engines. Experience proves that 3.5 - 5.0 HP is the most popular range of power for Taiwan farmers' needs. There is no doubt that rural Taiwan is going to be mechanized to solve the problem of power shortage and to improve rural life in a foreseeable future.

SUMMARY OF RECOMMENDATIONS OF THE SIXTH SESSION OF THE INTERNATIONAL RICE COMMISSION

The Sixth Session of the International Rice Commission met in Tokyo, Japan, 3–4 October, 1958, through the kind invitation of the Government of Japan. It was attended by 64 participants, representing 24 countries.

The Commission, having considered the various items on the Agenda of the Sixth Session, made the following recommendations:

1. The identity of the International Rice Commission should be maintained. The future sessions of the Commission may be held just prior to the FAO Regional Conference for Asia and the Far East and at the same place, but this should not be construed that the Commission is in any way subordinate to the FAO Regional Conference.

2. The Commission should continue to meet at two year intervals. Whether a future session of the Commission should be convened in conjunction with an FAO Regional Conference at the same place and just before it, or at a different place and a different time, should be decided by the

Director-General of FAO in the light of the prevailing circumstances. The future session of the Commission should be sufficiently long to allow time for adequate discussion.

3. The Commission in the future is to have three technical working parties as follows:

   a. Working Party on Rice Production and Protection.

   b. Working Party on Rice Soils, Water and Fertilizer Practices.

   c. Working Party on Agricultural Engineering Aspects of Rice Production, Storage and Processing.

   These Working Parties may organize special study groups when necessary for purposes of intensive investigation.

4. The frequency of meetings of the Working Parties should depend on the need for such meetings. Generally, they meet at two year intervals, either individually or jointly as the case may be. At times, one or more of the Working Parties may also meet in conjunction with a session of the Commission.

5. FAO should continue to keep in touch with government officials concerned with rice improvement through experts' visits, correspondence and publications, in order to carry out the work directly wherever possible and thus to reduce the number of technical meetings necessary.

6. FAO should help Member Governments in their rice improvement work through a comprehensive approach, including promotion and coordination of rice research projects and dissemination of new information and techniques and assistance in implementation of rice improvement activities.

7. FAO should continue the present three ETAP posts—Plant Protection, Rice Improvement and Soil Fertility through 1961 or 1962. These three experts are stationed in the FAO Regional Office at Bangkok, Thailand, to provide technical assistance to Member Governments in their respective fields. Commission proposed to FAO to establish two more ETAP posts in the Regional Office—one for rice soil classification and the other for agricultural engineering.

8. FAO was requested to prepare a background paper on revisions needed in the Constitution and Rules of Procedure of the Commission, for consideration by the Commission at its Seventh Session.

9. It was suggested to FAO that current literature on rice be abstracted and published in the IRC News Letter.

10. FAO should collect factual informa-

tion from Member Governments on accomplishments in rice improvement along the lines recommended by the various technical working bodies for consideration by the Commission at the Seventh Session.

11. The Commission requested the Director-General of FAO to give due consideration to the proposal of establishing an international rice research institute in the Region and to provide whatever assistance possible.

12. The Commission was pleased to welcome the invitation from the Delegate of Ceylon to hold the 1959 meetings of the two Working Parties on Rice Production and Protection and on Rice Soils, Water and Fertilizer Practices in Ceylon, and to record another invitation from the Delegate of the Philippines to hold the Seventh Session of the Commission in the Philippines in 1960. It was suggested that the latter invitation be taken into consideration by the Director-General of FAO when he decides on the plans for holding the 1960 FAO Regional Conference.

PROGRESS REPORT ON THE WORK OF THE INTERNATIONAL RICE COMMISSION

C. W. Chang

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Executive Secretary, International Rice Commission

At the Fifth Session of the International Rice Commission, which was held in Calcutta, India, 12-19 November 1956, there was a total of 22 recommendations made: 20 to FAO and two to Member Governments. Those recommendations that concerned FAO were either carried out or are in the process of being carried out. The present report summarizes only some of the highlights of the work of the Commission for the period under review.

1. Meetings held. The Seventh Meeting of the Working Party on Rice Breeding, the Sixth Meeting of the Working Party on Fertilizers, and the First Meeting of the ad hoc Working Group on Soil-Water-Plant Relationships of the International Rice Commission were jointly held at Vercelli, in September 1957, through the kind invitation of the government of Italy. These meetings were attended by a total of 47 participants representing 17 member governments, four non-member governments and one international organization. A joint report was issued, and copies of the report were made available to all governments and organizations concerned.

2. Training centers held or planned. The second regional farm management development center was held in New Delhi, India, from in October and November 1957, the first one being held in Tokyo, Japan, in October and November 1956. These two centers were established with special emphasis on rice. The third regional farm management development center is being planned to be held early in 1959 in Bangkok, through the kind invitation of the government of Thailand.

The third international training centers on rice breeding and on soil fertility were originally planned to be held this year in Tokyo through the kind invtiation of the government of Japan, but, due to lack of funds, the holding of these two centers will have to be postponed to a later date.

However, national training centers have been encouraged. By the end of this year five such centers will have been held

with FAO assistance: four on rice improvement and one on farm management.

3. **Advisory services provided.** In addition to Dr. H.N. Mukerjee who serves as FAO Regional Fertility Specialist, Dr. N. Parthasarathy was appointed this year to succeed Dr. K. Ramiah as FAO Regional Rice Breeding Specialist. These two specialists are stationed in the FAO Regional Office at Bangkok and are assisting Member Governments in Asia and the Far East through correspondence, field visits and the conducting of training centers.

4. **Publications issued.** FAO World Catalogue of Genetic Stocks of Rice, Supplement No. 6, was published in October 1957, thus bringing the total number of genetic stocks of rice registered in the Catalogue to 1,135.

A small pamphlet entiled "Agricultural Engineering" was issued as FAO Informal Working Bulletin No. 2. This bulletin tries to analyze the various operations and equipment most commonly used and to determine which implements and appliances could be introduced to increase efficiency and reduce labour.

The IRC News Letter now enters the seventh year of its publication. It is published quarterly and appears to be well received by its readers.

5. **Exchanges of rice seeds.** The exchange of seeds between Member Governments for trying out or breeding purposes has continued during the last two years. Since this is an important phase of the work of the Commission, it is expected that greater emphasis should be given to it in the future.

6. **Financial statement.** There have been no expenses incurred in any co-operative undertakings during the period under review. The remaining sum of $4,641.51 from contributions to the Rice Hybridization Project was recommended at the Fifth Session to be used for publishing the Agricultural Study on Rice which had been prepared by Dr. K. Ramiah. The manuscript is presently under review and will be published at a later date.

REPORTS OF THE COMMISSION AND ITS WORKING GROUPS

Reports of the Commission

Report of the First Session, Bangkok, Thailand, March 1949
Report of the Second Session, Rangoon, Burma, February 1950
Report of the Third Session, Bandung, Indonesia, Nay 1952
Report of the Fourth Session, Tokyo, Japan, October 1954
Report of the Fifth Session, Calcutta, India, November 1956
Report of the Sixth Session, Tokyo, Japan, October 1958

Reports of the Working Party on Rice Breeding

Report of the First Meeting, Rangoon Burma, February 1950
Report of the Second Meeting, Bogor, Indonesia, April 1951
Report of the Third Meeting, Bandung, Indonesia, May 1952
Report of the Fourth Meeting, Bangkok, Thailand, September 1953
Report of the Fifth Meeting, Tokyo, Japan, October 1954
Report of the Sixth Meeting, Penang, Malaya, December 1955

Reports of the Working Party on Fertilizers

Report of the First Meeting, Bogor, Indonesia, April 1951
Report of the Second Meeting, Bandung, Indonesia, May 1952
Report of the Third Meeting,Bangkok, Thailand, September 1953
Report of the Fourth Meeting, Tokyo, Japan, October 1954
Report of the Fifth Meeting, Penang, Malaya, December 1955

Report of the ad hoc Working Group on the Problems of Mechanization of Rice Production under Wet Paddy Conditions

Report of the First Meeting, Peradeniya, Ceylon, May 1956

Report of the ad hoc Working Group on the Problems of Storage and Processing of Rice

Report of the First Meeting, Calcutta, India, November 1956

Report of the ad hoc Working Group on the Problems of Soil, Water and Plant Relationships in the Production of Rice

A Preliminary Report by Correspondence, November 1956

Joint Report of the Seventh Meeting of the Working Party on Rice Breeding; the Sixth Meeting of the Working Party on Fertilizers; and the First Meeting of the ad hoc Working Group on Soil–Water–Plant Relationships

Held at Vercelli, Italy, September 1957.

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